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ABSTRACT

It has been reported that very little time is spent in the classroom on environmental education subjects unless the teacher has a special interest in the specific topic of study. This lack of time for environmental education coupled with the lack of adequate time allotted for mathematics and science instruction suggests that integrating the three--mathematics, science, and environmental education--into one learning activity can be a productive use of educational time at any grade level. This document presents a justification for integrating these subject areas. It then presents descriptions of 25 projects that are resources for integrated teaching activities for primary and secondary education, all with citations. The activities are documented in the ERIC database and most are reported with ERIC Document Reproduction Service Numbers. (Contains 12 references.) (PR)

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The Curriculum File

Integrating Science, Mathematics, and Environmental Education: Resources and Guidelines

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Clearinghouse for Science, Mathematics, and Environmental Education — *May 1993*

Science and Mathematics

The integration of mathematics and science with other subjects has been advocated for quite some time. Several large-scale initiatives have been suggested in the last few years. Project 2061: Education for a Changing Future, a proposal from the American Association for the Advancement of Science (American Association, 1989), suggests that students need to understand how science, mathematics, and other subjects strongly depend upon one another. The Holmes Group (a consortium of 96 U.S. research universities committed to making teacher preparation programs more rigorous) also wants curriculum constructed that uses the integration of several subjects in the curriculum because of the powerful learning that it provides (Griffin, 1991). Thirteen years ago the same ideas were presented in Project Synthesis, which appeared as Volume III of the "What Research Says to the Science Teacher" (Harms, 1980). Here it was deemed that the intermingling of mathematics and science with other subjects should be occurring in American education to produce better educated and informed citizens.

Currently it is being suggested that elementary and secondary schools may be falling short in educating students in mathematics and science and may often steer students away from these subjects (Senate Report 101-412, 1990). Howe, Blosser, Suydam, Helgeson, and Disinger (1987) note that by grade eight many students rate science and mathematics as their least favorite courses while elementary and high school students rate them among their most difficult courses.

Howe et al., (1987) found academic success in science and mathematics to be a strong correlate with positive attitudes and interest. Methods they reported available to enhance attitudes and interest include hands-on activities, working with other students, and energetic, interested teachers. Manipulatives used correctly can be a very necessary part of successful mathematics and science education (McBride & Silverman, 1991).

Much of science and mathematics education comes from textbooks and workbooks where the approach to teaching appears to be lecture and review. Also, teachers, it has long been recognized, tend to skimp on presenting newer concepts or topics that intimidate them or in which they lack adequate knowledge. For example, in many elementary classrooms mathematics and science are given small time frames usually near the end of the school day. It is difficult for the student to develop an appreciation for science or mathematics when the instructors themselves show little interest or motivation. Environmental topics may be the focal point for combining science and mathematics.

Environmental Education

It has been reported that very little time is spent in the classroom on environmental education subjects unless the teacher has a special interest in the specific topic of study (Howe et al., 1987). This lack of time for environmental education coupled with the lack of adequate time allotted for mathematics and science instruction suggests that integrating the three—mathematics, science, and environmental education—into one

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learning activity can be a productive use of educational time at any grade level.

Monroe (1991) states that the goal of environmental education is to "prepare citizens capable of acting on behalf of the environment." Disinger and Lisowski (1986) state that one of the tasks of environmental education is to integrate knowledge from the disciplines across the natural, social, and psychological sciences. The reaching of this goal can be aided by using environmental education concepts as a vehicle for delivering science and mathematics instruction by infusing the three into an approach to study environmental topics (Charles, 1990). Rarely do environmental problems not include mathematical and science oriented aspects (Monroe, 1991). Because science, mathematics, and environmental education are intermingled in everyday life it only follows that these should be similarly approached in the classroom to prepare students for the world outside of school (Wiebe, Ecklund, & Hillen, 1986).

Integration Justification

Why is it important that these three areas be integrated? Environmental education concepts affect all people regardless of race or nationality. Environmental education is a model for encouraging students to consider how their behavior affects other people and conditions of the environment (Yambert, Dillon, & Donow, 1985). Students should have an opportunity to be educated so that they can properly respond to environmental problems that will arise in their lives, and to do so they need to be taught problem-solving and decision-making techniques. A knowledge base is also critical to working in this arena. If students are to help protect the environment, they need not only a willingness to act but also an understanding of ecological and scientific fundamentals (Beatty, 1978).

The incorporation of mathematics into real-life environmental situations is also valuable because mathematics is a creative process in itself—not one that just utilizes recalled concepts and programmed answers (American Association, 1989). Mathematics needs to be integrated to other areas of the curriculum so children can make connections between abstract mathematical concepts and real life situations (McBride & Silverman, 1991). Mathematics can provide clarity, objectivity, and understanding to problems at hand. The combination of science, mathematics, and environmental education activities allows for varied approaches and applications to mathematical topics. Students are often given a chance to study problems and attempt their own solutions in science/mathematical/environmental activities. Mathematics is an important resource in the determination of possible solutions to these activities (Monroe, 1991). This allows students to be creative in mathematical thought without necessarily worrying about arriving at the "right" answer. Typically, problem solving is involved in these combined approaches, giving students the opportunity to center their thoughts and use all of their available mathematical and reasoning concepts.

Science provides the principles of questioning, investigating, hypothesizing, and discovering. Many issues of society today involve complications from the advancements of science (Beatty, 1978). Studying and evaluating these problems can aid the student in developing decision-making processes where the student can work with real environmental problems currently facing the planet or those in the future. In order to best approach these problems a working knowledge of certain components of science are fundamental for the qualifications needed for competent citizenry (Monroe, 1991).

Summary

The integration of mathematics, science, and environmental education permits the students to gain from all three areas simultaneously. Science encompasses the art of questioning, investigating, hypothesizing, and discovering. Mathematics is the language that provides clarity, objectivity, and understanding. Many of the major contemporary

issues involve societal issues stemming from advancements in science (Wiebe, Ecklund, & Hillen, 1986). Problem solving, creative mathematics and science thinking, core knowledge, decision making, and environmental training are all available in one time period in a properly conceived and directed activity. Teachers, too, are more interested when using methods and concepts more familiar to them. By increasing awareness and making a more effective use of classroom time we may get closer to producing the informed citizen needed for today's world.

References

American Association for the Advancement of Science. (1989). *Science for all Americans: Summary, project 2061.* Washington, DC: AAAS Books. (ERIC Document Reproduction Service No. ED 309 060)

Beatty, M. T. (1978). Natural and environmental resource programs: University of Wisconsin extension as a case study in environmental education. In C. Schoenfeld & J. Disinger (Eds.), *Environmental education in action-II: Case studies of environmental studies programs in colleges and universities today.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 152 557)

Charles, C. (1990). Wholeearth learning: Sustaining and enhancing a liveable future. *Clearing, 65.* pp. 3, 4, 34, 35.

Congress of the U.S. (1990). *Excellence in mathematics, science, and engineering act of 1990.* (Senate Report 101-412, 101st Congress, 2d Session). Washington DC: Senate Committee on Labor and Human Resources.

AAAS. (1986). Response to "crisis in science education". (1986). *Science, 234*(**4777**), 752-753.

Disinger, J. F., & Lisowski, M. (1986). *Teaching activities in science/society/technology/environment.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 282 711)

Griffin, G. (1991). *Toward a community of learning: The preparation and continuing education of teachers.* A Report of the Curriculum Committee of the Holmes Group to University and School Faculty Engaged in Educating Teachers. East Lansing, MI: Holmes Group, Inc. (ERIC Document Reproduction Service No. ED 330 650)

Harms, N. (1980). *Project synthesis: An interpretive consolidation of research identifying needs in natural science education* (Final Report). Boulder, CO: Colorado University. (ERIC Document Reproduction Service No. ED 216 885)

Howe, R. W., Blosser, P. E., Suydam, M. N., Helgeson, S. L., & Disinger, J. F. (1987). *Persistent problems in precollege mathematics, science, and environmental education: Issues, trends, and recommendations.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 281 910)

McBride, J. W., & Silverman, F. L. (1991). Integrating elementary/middle school science and mathematics. *School Science and Mathematics, 91*(7), 285-292.

Monroe, M. C. (1991). Meeting the mandate: Integrating environmental education. *Clearing, 71,* 8-11.

Wiebe, A., Ecklund, L., & Hillen, J. (1986). *Overhead and Underfoot* (Book D). Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 696)

Yambert, P. A., Dillon, R. F., & Donow, C. F. (1985). Environmental education activities to enhance decision-making. (ERIC Document Reproduction Service No. ED 253 437)

TEACHING ACTIVITIES

Many teaching activities and ideas for use in primary and secondary education concerning the integration of mathematics, science, and environmental education can be found in the ERIC database. Provided below is a brief description of several of these activities:

Project C.A.R.E. is to develop in elementary students a sense of responsibility towards animals that are part of our lives. Nine activities are provided. [Rhyne, P., & Mitchell, J. (1986). *Project C.A.R.E. caring for animals: Responsible education.* Marietta, GA: Kennesaw College. (ERIC Document Reproduction Service No. ED 284 743)]

Population provides four activities for elementary students concerning census taking, exponential growth, and a growing world population. [Holm, A. E. (1986). *Population: Global issues education packet.* Washington, DC:Global Tomorrow Coalition. (ERIC Document Reproduction Service No. ED 297 980)

Wet and Wild Water provides activities for elementary students on water economics; water sports, athletes, and water animals; famous explorers; myths, legends, and strange occurrences; and global responsibility. [Indiana State Department of Education. (1990). *Wet and wild water.* Indianapolis, IN: Center for School Improvement and Performance. (ERIC Document Reproduction Service No. ED 338 478)]

Maude Visits... uses a fictional Maude character in travels around the world using filmstrips and audiotapes. This article discusses using Maude to teach about maps, money, heat movement, and other science concepts. [Rubino, A. M., & Duerling, C. K. (1991). Around the World in Science Class. *Science and Children, 28*(7), 37-39.]

Coastal Capers is a marine education primer to introduce the marine environment to elementary students. It provides activities on counting, mapping, graphing, and others. [Spence, L., & Cox, V. B. (1984). *Coastal capers: A marine education primer.* Raleigh, NC: North Carolina State University. (ERIC Document Reproduction Service No. ED 276 597)]

Magic Day provides elementary students with activities that encourage environmental awareness by movement, touching, feeling, tasting, and sharing experiences gained from investigating cemeteries. [Wall, G., Crump, C., Del Grande, V., & Squires, F. (1992). *Magic day multi-disciplinary multi-sensory awareness gathered and integrated into the curriculum.* (ERIC Document Reproduction Service No. ED 352 271])

Overhead and Underfoot provides many activities for elementary students K-4 on weather, plants and animals, pollution, and soils and rocks. [Wiebe, A., Ecklund, L., & Hillen, J. (1986). *Overhead and Underfoot* (Book D). Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 696)]

Planet Patrol is intended to convey an understanding of the four methods of solid waste handling as recommended by the EPA. Four activities are provided for grades 4-6. [Shively, P. J. (Ed.). (1990). *Planet patrol: An educational unit on solid waste solutions for grades 4-6.* Cincinnati, OH: Proctor and Gamble. (ERIC Document Reproduction Service No. ED 331 707)]

Soil and Water Conservation integrates soil and water conservation into the 4th, 5th, and 6th grade classroom building an awareness of food production. It contains activities on land surveying, rainfall amounts, and calculating soil loss. [Patterson, J. (1986). *Farm and food bytes: Soil and water conservation* (Teacher's Guide and Student Study Manual). Ankeny, IA: Soil and

Water Conservation Society. (ERIC Document Reproduction Service No. ED 289 705)]

Environmental Education Activities to Enhance Decision-Making provides activities on foods in other lands, shopping: an environmental adventure, a stake in the land, and measuring silos. [Yambert, P. A., Dillon, R. F., & Donow, C. F. (1985). *Environmental education activities to enhance decision-making*. (ERIC Document Reproduction Service No. ED 253 437)]

Our Wonderful World provides nineteen activities for 5th through 8th graders on air, water, transpiration, soil, plants, and animals/insects. [Wiebe, A., Ecklund, L., & Mercier, S. (1986). *Our wonderful world: Solutions for math + science* (Environmental Studies, Book 7). Fresno, CA: AIMS Education Foundation. (ERIC Document Reproduction Service No. ED 283 706)]

Beaches introduces junior high students to the physical and biological processes of the beach zone. Contains four activities encompassing ten days. [Marrett, A. (1980). *Beaches: Ocean related curriculum activities*. Seattle, WA: Pacific Science Center. (ERIC Document Reproduction Service No. ED 289 674)]

Beach Profiles and Transects provides instruction on 1) how to measure and record the profile of a slope and 2) sampling populations using the single line transect quadrat method. Provides eight activities for junior high students. [Jones, C. (1980). *Beach profile and transects: Ocean related curriculum activities*. Seattle, WA: Pacific Science Center. (ERIC Document Reproduction Service No. E 289 673)]

What are the ABC's of Marine Education? includes ideas and activities for junior high students focusing on the Gulf of Maine to be used in entirety or as sources for usual curricula. Contains activities on aquariums, commercial fisheries, estuaries, glaciation, the ocean, ponds and puddles, uses of the sea, and zones. [Butzow, J. W. (1982). *What are the ABC's of marine education? An introduction to marine education in the Gulf of Maine region*. MN: Maine University. (ERIC Document Reproduction Service No. ED 238 726)]

Multidisciplinary Wildlife Teaching Activities contains many ideas and activities for all areas. Among those included for junior high students include building a bird nest, animal tracks, drinking water, desert tortoise, how long does it take?, animals can tell Fahrenheit, and many others. [Hernbrode, W. R. (1978). *Multidisciplinary wildlife teaching activities*. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 162 897)]

Elementary Acid Rain Kit provides six activities for grades 4-8 on logarithms, measuring pH, neutralization, and acid rain. [Stubbs, H. S., Klinkhammer, M. L., & Knittig, M. (1985). *Elementary acid rain kit, grades 4-8*. St. Paul, MN: Acid Rain Foundation. (ERIC Document Reproduction Service No. ED 270 302)]

Teaching About Hazardous and Toxic Materials provides 2 activities (among others) 1) Where do they come from? for grades 4-6 identifies the sources of solid waste and the problems associated with production levels. 2) Pesticides: Blessing or Curse? for grades 7-9 identifies information from pesticide labels to determine toxicity and potential hazards. [Disinger, J. F. & Lisowski, M. (1985). Teaching about hazardous and toxic materials. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 273 432)]

The Township of Ocean School District Contemporary Science Curriculum Guide describes a full year, cost effective course which encourages active participation for non-academic, disaffected to college bound high school students

alike. Among other topics discussed are: population, pollution, water pollution, noise pollution, and energy resources. [Truex, R. T. (1987). *Township of ocean school district contemporary science* (Curriculum Guide). Trenton, NJ: New Jersey State Department of Education. (ERIC Document Reproduction Service No. ED 327 413)]

Population Education Awareness Activities discusses methods to help students become aware of population growth. Provides ideas for making a difference in population growth. [Brouse, D. E. (1990). Population education awareness activities. *The Science Teacher, 57*(9), 30-33.

Marine Science Project describes an activity oriented marine science curricula for teaching basic marine science skills and knowledge for grades 2, 4, 6, 7-8, and 9-12. [Marganoff, B. (Ed.). (1991). *A resource guide to elementary science programs: National, state and community-based programs.* New Jersey Department of Education. (ERIC Document Reproduction Service No. ED 338 481)]

Project Learning Tree provides a description of a program which provides teaching strategies, activities, and resources to help students become aware of their presence in the environment, their impact upon it, and their responsibility for it. [American Forest Foundation. (1987). *Project learning tree: A program of the American Forest Foundation.* Washington, D.C. (ERIC Document Reproduction Service No. ED 290 612)]

Teaching in the Outdoors is a book devoted to providing hundreds of ideas for instructing students of all ages utilizing areas available outside of the school building. [Hammerman, D. (1985). *Teaching in the outdoors.* Danville, IL: Interstate Printers and Publishers. (ERIC Document Reproduction Service No. ED 282 718)]

101 Ways to Teach about Exponential Growth and its Consequences provides ideas and activities on exponential growth and its consequences. It also provides background information for teachers. [Allen, R. F. (1983). *101 ways to teach about exponential growth and its consequences.* Sebring, FL: Tri-County Teacher Education Center. (ERIC Document Reproduction Service No. ED 225 856)]

Teaching Activities in Science/Society/Technology/Environment contains many activities for all grade levels and disciplines. Worksheets and discussion questions are provided. [Disinger, J. F., & Lisowski, M. (1986). *Teaching activities in science/society/technology/environment.* Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 282 711)]

Teaching Basic Skills through Environmental Education Activities provides 22 activities (among others) for all levels. These range from counting leaves to noise absorption by trees to river carrying capacity. [Bowman, M. L. (1979). Teaching basic skills through environmental education activities. Columbus, OH: ERIC Clearinghouse for Science, Mathematics, and Environmental Education. (ERIC Document Reproduction Service No. ED 196 704)

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